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Research Article

EFFECT OF FOOD PLANTS ON THE GROWTH AND DEVELOPMENT OF SMALL RICE GRASSHOPPER, *OXYA FUSCOVITTATA* (MARSCHALL)

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ABSTRACT

Investigations on the effect of food plants on the growth and development of the small rice grasshopper, Oxya fuscovittata (Marschall) were carried out over two kharif (monsoon) crop seasons (2008 and 2009). Growth and development of O. fuscovittata was best on Oryza sativa L. ranking first followed by Cyperus rotundus L. ranking second; resultantly, the development period on O. sativa, manifested by hopper duration, was the lowest and survival was 100 per cent; consequently, the growth index was the highest (2.87 and 2.85) during both years (2008-09 and 2009-10). The plants of Graminae (Poaceae) were the more preferred food plants having secured ranks from I to VII and the developmental period ranged from 34.79 to 39.98 days. The host Glycine max (ranking VIII), a dicot plant was least preferred by the grasshopper and the hoppers took 46.16 days to complete their development. The food utilization indices, efficiency of conversion of ingested food (ECI), approximate digestibility (AD) and efficiency of conversion of digested food into body substances (ECD) were the highest when the grasshopper (O. fuscovittata) was fed on O. sativa.

***KEYWORDS:** Acrididae, Hopper Survival, Gowth Index, Food Utilization, Oryza Sativa L*

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INTRODUCTION

It is a well established fact that food plants are known to affect the biology and behaviour of insects including rate of growth and development, survival, fecundity and fertility (Pickford, 1962; Banjerjeet and Haque, 1985; Aslam and Whitworth, 1988). An overall majority of phytophagous insects restrict host plant use to closely related groups of plant species, sometimes even a single species (Berneys and Chapman, 1994). In nature, acridids are important components of agriculture fields, grasslands, and forest under-storey; and their global pest status has been reviewed in detail (Jago, 1998). acridids are commonly specialist and generalist feeders and among them, some feeds exclusively on graminaceous plants, others only on dicots and some on both (mixed feeders). Among the different acridids, the genus *Oxya* has been reported to cause considerable damage to paddy at the seedling stage (Dean, 1976; Irshad *et al.*, 1977; Singh and Sinha, 1978; Garg and Tandon, 1983; Thakur, 1984); besides it also infests maize, sugarcane, sorghum and fodder crops. Earlier, various studies in areas such as biology, ecology, behaviour and bionomics have been done on different species of the genus *Hieroglyphus*. However, there is no detailed study of the effect of food plants on growth and development of *O. fuscovittata*. Hence, the research on growth and development of this species on preferred food plants will be instrumental in understanding and devising population management strategies, which could help avoiding or preventing any possible future outbreak.

MATERIALS AND METHODS

Field collected adults of the grasshopper, *Oxya fuscovittata* Marschall, were reared during 2008 and 2009 in the laboratory on fresh and untreated paddy leaves as food and the live culture was maintained in aluminium frame wire-gauge cages kept on steel racks protected from ants. The adults were put into the wire-gauge cages (30 x 30 x 30 cm), wherein they were allowed to mate and lay eggs.

For food plant preference studies during each year, newly hatched-out hoppers were maintained on leaves of paddy until they moulted twice. Healthy III instar hoppers, starved for 6 hours were transferred singly into individual wooden wire-gauge cages (15 x 7.5 x 7.5 cm) having a furnished bottom with small dry twigs to facilitate moulting. Four replications of 10 hoppers each were maintained on fresh leaves from the 8 different food plants, selecting 5 from cultivated crops and 3 from uncultivated pasture grasses and weeds. Fresh food was provided twice daily. The food plants selected as treatments were: paddy, *Oryza sativa* L.; maize, *Zea mays* L.; sugarcane, *Saccharum officinarum* L.; sorghum, *Sorghum bicolor* (L.) Moench.; soybean, *Glycine max* (L.) Merr.; Purple nutsedge, *Cyperus rotundus* L.; Yellow foxtail, *Setaria glauca* (L.) Beauv. and Bermuda grass, *Cynodon dactylon* (L) Pers.

Observations were recorded for each subsequent hopper period (in days). The time required for adult development on each food plant was recorded and the survival of adults was recorded. To compare the relative growth of hoppers on different food plants the survival index was calculated using the following formula:

$$\text{Survival index} = \frac{\text{Percent hoppers attaining V instar}}{\text{Duration of hoppers (in days)}}$$

Food utilization indices were calculated on a dry weight basis for the newly formed V instar hoppers. The hoppers reared on paddy right from hatching, were starved overnight, and thereafter provided with the different food-plants until they develop into adults. Fresh, tender green parts of the different food plants were divided into two equal portions. One portion was weighed wet and fed to the newly formed and starved V instar hopper, while the other portion taken as aliquot. The aliquot food was weighed wet first, then dried at 80^{o} C in an oven and the dry weight was recorded. Leftover food and faeces were removed every 24 hours and dried to a constant weight at 80^{o} C. At the end of the experiment the newly formed adults were starved to devoid their guts of residual faecal material. Faeces for the period of starvation were also collected every 24 hours. After starvation, the newly formed adults were killed and dried to a constant weight at 80^{o} C in an oven.

Calculation of Food Utilization Indices

Having recorded the dry weight of leftover food and faeces, the quantity of ingested food was calculated by subtracting it from the weight of the food introduced. The approximate weight of digested food was calculated by subtracting the weight of faeces from the weight of the ingested food. From these values, on a dry weight basis, the utilization indices were computed (Waldbauer, 1968):

$$\text{Efficiency of conversion of ingested food [ECI]} = \frac{\text{Weight gained}}{\text{Weight of food ingested}} \times 100$$

$$\text{Approximate digestibility [AD]} = \frac{\text{Wt. of food ingested} - \text{Wt. of faeces}}{\text{Weight of food ingested}} \times 100$$

$$\text{Efficiency of conversion of digested food into body substances [ECD]} = \frac{\text{Weight gained}}{\text{Wt. of food ingested} - \text{Wt. of faeces}} \times 100$$

RESULTS AND DISCUSSIONS

The study on the effect of food plants on the growth and development of *O. fuscovittata* indicated a preference for *Oryza sativa* L. ranking first followed by *Cyperus rotundus* L. ranking second (Tables 1 and 2). The developmental period manifested by the hopper duration was the lowest (34.79 days); the survival was 100 per cent; and the growth index was the highest (2.87) during 2008-09. Similarly, in the subsequent year too, *O. sativa* was the most preferred food and the corresponding figures were 35.05 days (hoper duration), 100 per cent (survival), and 2.85 (growth index) on paddy. Results clearly show that plants of Graminae (Poaceae) were the more preferred food plants having secured ranks from I to VII and the developmental period ranged from 35.40 to 39.98 days. Soybean (*Glycine max*) that ranked VIII was least preferred by the grasshopper and the hoppers took 46.16 days to complete their development.

The order of preference of different food plants in a descending order was as: *Oryza sativa* > *Cyperus rotundus* > *Zea mays* > *Saccharum officinarum* > *Sorghum bicolor* > *Setaria glauca* > *Cynodon dactylon* > *Glycine max*. In early reports, Aziz and Aziz (1985) recorded a descending order of preference for late instar hoppers and adults of *Oxya velox* as mixed diet of rice, *Cyanodon dactylon* and *Echinocloa colonum* > rice > wheat > *E. colonum* > *Hemarthira compressa* > *Setaria verticillata* > maize > pearl millet; while, *Trifolium alexandrium* was not fed upon at all.

CONCLUSIONS

From Table 3, it becomes evident that when the grasshopper (*O. fuscovittata*) was fed on paddy the food utilization indices were the highest. The values for efficiency of conversion of ingested food (ECI), approximate digestibility (AD) and the efficiency of conversion of digested food into body substances (ECD) were 35.05, 72.19 and 48.58 during 2008-09 and 36.36, 73.38 and 49.56 per cent during 2009-10, respectively. However, the approximate digestibility (70.71 and 72.18 per cent) was equally high, when the hoppers were reared on *C. rotundus* during 2008-09 and 2009-10, respectively. Among the different food plants, *S. glauca* and *C. dactylon* were statistically at par with respect to ECI, AD and ECD values during both the years. Similarly, *S. bicolor* and *S. officinarum* showed no significant difference for these values during 2008-09. The ECI, AD, ECD values were significantly the lowest, when hoppers were raised on *G. max*. Therefore, it could be inferred that the acridid, *O. fuscovittata* is typically a grass feeder, as is evinced by the first to seventh ranks occupied by plants of Poaceae and the eight rank occupied by the dicot, *G. max* (Fabaceae). It might also be deduced that the protein requirements for *O. fuscovittata* is relatively lower, which is more in the legumes than in the grasses. Early reports indicate that mixed feeding by insect herbivores is relatively uncommon (Mulkern *et al*., 1969; Joern, 1983). Forbs usually make up the bulk of mixed feeder diets with grasses' contribution a variable but often minor component (Joern, 1983; Bernays and Bright, 1993). As seen in most polyphagous species, which perform best on diets containing plants from multiple families (Rapport, 1980; Hägele and Rowel-Rahier, 1999), mixed feeding herbivores also experience their greatest performance when both forbs and grasses are consumed (Bailey and Mukherji, 1976; McFarlane and Thorsteinson, 1980; Randolph *et al*., 1995; Hägele and Rowel-Rahier, 1999; Randolph and Cameron, 2001; Miura and Ohsaki, 2006).

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APPENDICES

Table 1: Effect of Food Plants on the Development of *O. fuscovittata* (2008-09)

Food Plants	Average Hopper Duration (days)				Hopper Survival (%)	Growth Index	Rank
	III Instar	IV Instar	V Instar	Total			
Oryza sativa L.	10.68	11.53	12.58	34.79	100.00	2.87	I
Zea mays L.	11.15	12.03	13.25	36.43	100.00	2.74	III
Sorghum bicolor (L.) Moench.	11.72	12.63	13.68	38.03	97.50	2.56	V
Saccharum officinarum L.	11.33	12.27	13.58	37.18	100.00	2.69	VI
Glycime max (L.) Merr.	14.05	15.18	16.35	45.58	77.50	1.70	VIII
Setaria glauca (L.) Beauv.	12.25	12.93	13.90	39.08	92.50	2.37	VI
Cyperus rotundus L.	10.87	11.73	12.80	35.40	100.00	2.82	II
Cynodon dactylon (L.) Pers.	12.35	13.13	14.08	39.56	92.50	2.34	VII

Table 2: Effect of Food Plants on the Development of *O. fuscovittata* (2009-10)

Food Plants	Average Hopper Duration (days)				Hopper Survival (%)	Growth Index	Rank
	III Instar	IV Instar	V Instar	Total			
Oryza sativa L.	10.55	11.78	12.72	35.05	100.00	2.85	I
Zea mays L.	11.30	12.13	13.33	36.76	97.50	2.65	III
Sorghum bicolor (L.) Moench.	11.57	12.60	13.73	37.90	95.00	2.51	V
Saccharum officinarum L.	11.40	12.33	13.50	37.23	100.00	2.69	VI
Glycime max (L.) Merr.	14.25	15.33	16.58	46.16	72.50	1.57	VIII
Setaria glauca (L.) Beauv.	12.02	12.85	13.97	38.84	95.00	2.45	VI
Cyperus rotundus L.	10.95	11.83	12.88	35.66	100.00	2.80	II
Cynodon dactylon (L.) Pers.	12.58	13.20	14.20	39.98	90.00	2.25	VII

Table 3: Effect of Food Plants on the Food Indices for *Oxya fuscovittata* (Marschall)

Food Plants	2008-09			2009-10		
	ECI (%)	AD (%)	ECD (%)	ECI (%)	AD (%)	ECD (%)
Oryza sativa L.	36.30	58.18	44.19	37.08	51.25	44.75
	(35.05)	(72.19)	(48.58)	(36.36)	(73.38)	(49.56)
Zea mays L.	32.11	54.31	40.91	32.40	49.85	41.14
	(28.25)	(65.96)	(42.88)	(28.71)	(66.53)	(43.29)
Sorghum bicolor (L.) Moench.	33.12	55.46	41.55	33.57	47.94	42.05
	(29.85)	(67.85)	(43.99)	(30.57)	(68.15)	(44.86)
Saccharum officinarum L.	33.51	55.69	41.95	34.57	48.90	42.79
	(30.48)	(68.22)	(44.68)	(32.19)	(69.78)	(46.14)
Glycine max (L.) Merr.	19.34	44.08	28.43	20.17	41.81	29.29
	(10.97)	(48.39)	(22.67)	(11.89)	(49.65)	(23.94)
Setaria glauca (L.) Beauv.	30.28	51.66	40.01	30.94	46.59	40.41
	(25.43)	(61.52)	(41.34)	(26.43)	(62.87)	(42.02)
Cyperus rotundus L.	34.76	57.22	42.70	35.77	50.64	43.49
	(32.50)	(70.71)	(45.99)	(34.17)	(72.18)	(47.37)
Cynodon dactylon (L.) Pers.	30.83	52.64	40.15	30.91	46.28	39.73
	(26.27)	(63.17)	(41.58)	(26.39)	(64.53)	(40.86)
S. Em. ±	**0.495**	**0.594**	**0.315**	**0.527**	**0.495**	**0.394**
CD (P=0.05)	**1.50**	**1.80**	**0.95**	**1.59**	**1.50**	**1.19**

Figures in parentheses are re-transformed values

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